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ABSTRACT

The newly constituted further education sector in Ireland was developed by the National Council for Vocational Awards. The mathematics for this sector was introduced as Mathematical Methods Level 2 on a pilot basis. The standard module's level proved to be too high, based on high failure rates. A review of the mathematics provision initiated these two approaches to deal with the problem: a short term strategy to modify the existing test procedure and a long term strategy to develop a new module as part of a proposed three-level mathematics framework. Practitioners were surveyed for the review process and the demographics of the test takers were examined. This survey showed that the revised module should have a vocational thrust, there was too much or inappropriate assessment previously, and the standard should change delivery in the classroom. A workshop was held to review the draft modules and a pilot study was performed on the revised drafts. Additional revisions were made based on pilot results. The new modules were an improvement, had new material for all learners, and had assignments that learners liked. The vocational approach was interesting to learners, and some concerns about one module still lingered. (Contains 6 references.)(SLR)

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Developing a National Framework for Adults' Mathematics Education in Ireland: A Pilot Study

Terry Maguire
National Council for Vocational Awards, Ireland

John O'Donoghue
Department of Mathematics and Statistics, University of Limerick, Ireland

Introduction

The authors have been involved in the development of a national framework for adult mathematics education within the remit of the National Council for Vocational Awards (NCVA). This work has been reported at previous ALM conferences, most recently at ALM-6 (O'onoghue, in press), where the proposal for a national framework was presented and discussed in a workshop. This work has continued under the aegis of the NCVA. One level of the national framework for adult mathematics education, namely, Mathematics, Level 2, was piloted during the academic year 1999/2000.

This paper reports on issues related to the pilot study that was directed by the authors from October 1999 to May 2000. It is intended to make Mathematics Level 2 available on a national basis from September 2000. The role of practitioners in this process is highlighted as it is novel in the context of national curriculum developments in Ireland.

Educational Context

Ireland has a highly centralised education system (see O'Donoghue, 1995, and Colleran & O'Donoghue, 1998, for a more detailed treatment of the system). There are now four distinct levels, Primary (4-12+); Second level (12-17+); a newly constituted Further Education sector; and Higher Education. Central in the emergence of the Further education sector as a distinct level within the Irish education system has been the work of the National Council for Vocational Awards (see O'Donoghue, in press).

The process of mathematics curriculum development has evolved in Ireland from being determined centrally by the Department of Education and Science to the current partnership arrangement where the partners in the process are consulted before new syllabuses are introduced. The evolution from curriculum by decree to a negotiated curriculum and on to the current partnership arrangement is well documented (Oldham, 1992, 1993).

Background and Work to Date

O'Donoghue (1995, p. 404) posed the question "*What is the appropriate mathematics for the emerging FE sector?*" The author suggested as a solution an appropriately graded numeracy programme which includes functional mathematics for individual needs, employment-oriented mathematics, basic mathematics on which to build further studies, and entry standard mathematics for higher education.

In 1996 NCVA introduced Mathematical Methods Level 2 on a pilot basis. The standard set was targeted at a level that subsequently proved too high. This was evident from the high failure rates for the module (Figure 1) and supported by feedback from practitioners at centres. This situation was problematic in itself but assumed added importance because:

- mathematics acts as a gatekeeper to entry to this type of programme as many Irish Institutes of Technology specifically require successful completion of mathematics at NCVA level 2 or equivalent; and
- more candidates (~250 in 1996 increasing to ~900 in 2000) were completing the module to gain entry to technological-type programmes in Higher education, mainly Institutes of Technology.

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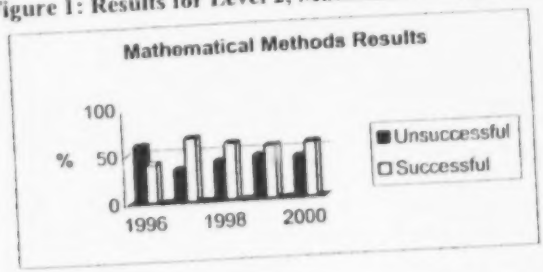
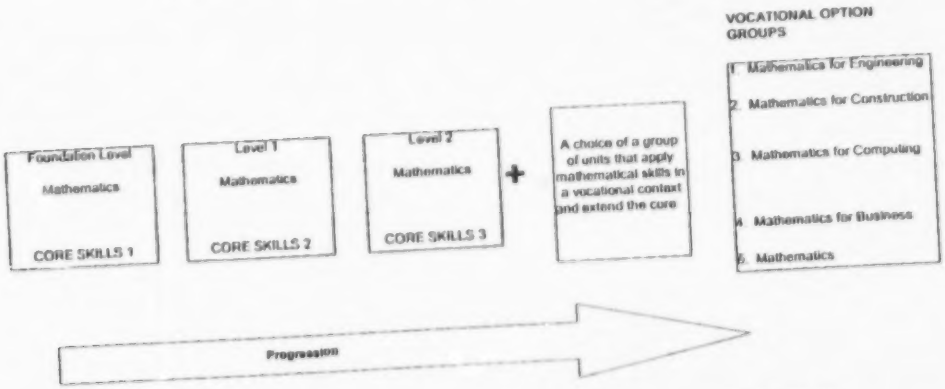
Figure 1: Results for Level 2, Mathematics 1996-2000



Subsequently the NCVA initiated a review of mathematics provision. The review group instituted a twin-track approach to deal with the situation.

- A short-term strategy, that involved increasing candidate question choice and time available to complete the examination was put in place to deal with learners currently enrolled in Mathematical Methods.
- A longer-term strategy to develop a new Level 2 Mathematics module, the proposal for a national framework for adults' mathematics education that articulates three levels of mathematics, Foundation, Level 1 and Level 2 was developed by the NCVA (O'Donoghue, in press). This framework is comprised of a progressive core (essentially concerned with number, geometry, algebra, data handling/chance) leading to vocational units related to specific vocational areas (Figure 2).

Figure 2: Proposed National Framework for Mathematics


VOCATIONAL OPTION GROUPS
1. Mathematics for Engineering
2. Mathematics for Construction
3. Mathematics for Computing
4. Mathematics for Business
5. Mathematics
Foundation Level Mathematics
CORE SKILLS 1
Level 1 Mathematics
CORE SKILLS 2
Level 2 Mathematics
CORE SKILLS 3
+
A choice of a group of units that apply mathematical skills in a vocational context and extend the core
Progression

Foundation Level Mathematics - This module develops core skills that relate to elementary number concepts.

Level 1 Mathematics - This module extends core skills 1 (numeracy, geometry, algebra, statistics) and provides learners with an opportunity to create and consolidate the base from which they can further develop their mathematical knowledge and skills.

Level 2 Mathematics - The mandatory core of mathematical skills extends the learner's foundation in essential mathematics and provides the basis for progression from Foundation Level to Level 1 to Level 2 and from Level 2 to higher education. Optional module units that extend these mathematical skills in an applied context provides the vocational focus to cater for the needs of a range of occupations e.g. Business, Computing, Construction, Engineering and Mathematics.

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Dialogue with Practitioners

The group set up to review mathematics provision resolved from the outset to involve practitioners in every aspect of the process and measures were taken to ensure that this happened.

Practitioner Questionnaire and Feedback

In Summer 1998 practitioners[1] were surveyed and given the opportunity to input into the review process at an early stage. This survey revealed that the existing level 2 module was delivered by centres as part of technology-based courses (computing, engineering, electronics, etc.). Forty percent of the candidates who successfully completed these courses progressed to Higher Education. Sixty percent of the candidates are over 18 years of age. Eighty percent of candidates achieved a grade C or less in mathematics at Leaving Certificate ordinary level.

Practitioners were asked to rank the factors they thought influenced performance in mathematics at level 2 (Figure 3).

Figure 3: Factors Influencing Performance in the Mathematical Methods Module (as indicated by practitioners)

1 The calibre of the candidate completing the module	Most Likely
2 How the module is written and the standard that it sets	⇓
3 The numbers of teaching hours available	
4 The way the module is delivered and the resources in the centre	
5 The way the module is assessed.	Least Likely

Gathering practitioner views is an integral part of the NCVA development process. The detailed information obtained through the use of the questionnaire gave valuable information on all aspects of the existing module and provided a springboard from which the review group could begin to revise the standard for mathematics at level 2.

The initial work of the review group focused on the following:

1. the revised module should have a vocational thrust.
2. the level of the content should be adjusted
   - there was too much or inappropriate assessment.
   - the new modules must be different from the leaving certificate so that candidates are not given *more of the same*.
   - the standard should be the catalyst for changing delivery in the classroom.

By September 1999, a drafts of three new modules were completed: Mathematics, Mathematics for Computing, Mathematics for Engineering. The NCVA approved the modules to run on a pilot basis during 1999/2000.

The review group recommended that practitioners should be given the opportunity for further input at this stage in the development process. All practitioners were invited to attend a workshop to consider the new modules in mathematics.

Workshop for Practitioners

The format for the workshop involved a series of brief presentations covering the vocational framework, mathematics teaching, innovative approaches to assessment, and an overview of the rationale behind each of

[1] Number of practitioners surveyed = 30, number of respondents = 15.

the units in the modules.[2] Practitioners were encouraged to adopt new approaches to delivery and assessment.

Support notes with sample assignments and questions drafted by the review group were circulated giving a clear indication of the standard. There was an opportunity for practitioners to discuss elements of the modules with a vocational specialist from the review group. Changes were subsequently made to the modules as a result of these discussions.

In all, 37 practitioners attended (about 90% of those delivering the module). The feedback on the proposal for the mathematics framework was very positive. Practitioners were interested in the approach to assessment by assignment, project, etc, rather than the traditional examination. However, many expressed concern about the availability of resources to support the new modules and whether, even with the new approach, their learners would successfully complete the modules.

As part of this process practitioners were invited to volunteer to use these modules as part of the pilot for 1999/2000. Those who agreed were required to provide feedback to the review group on their approach to delivery and assessment.

About half of those at the workshop expressed an interest in becoming part of the pilot. The others felt that:

- since the workshop was held in early October by which time learners had already started their programme it was too late to change from the existing module.
- opportunities for candidates to progress to Higher Education might be compromised since the new modules had not been formally approved for the Higher Education Links Scheme (a formal articulation agreement between Further and Higher Education).

Pilot Phase

The pilot was limited to six centres. Four of the centres were dedicated Colleges of Further Education; the remaining two also delivered at second level.

Five centres piloted Mathematics for Computing and one centre piloted Mathematics for Engineering. About a quarter of all candidates for mathematics at level 2 in 1999/2000 were included in the pilot group.

The practitioners met again in March 2000. By then all had completed the core units and were working on delivering the vocational units. Comments on the new modules were positive. The group shared the approach that they had taken to assignments and agreed sample examination questions for the vocational units.

The main concern was with the content of the vocational units in Mathematics for Computing. Practitioners themselves were having great difficulty coming to grips with teaching mathematics in a vocational context.

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[2] Core units: (All Modules)
Unit 1: Modelling using Mathematics; Unit 2: Graphs, Functions and Rates; Unit 3: Geometry and Trigonometry:; Unit 4: Statistics and Chance;

Vocational Units:
Mathematics *Unit 5: Further Calculus; Unit 6 : Complex Numbers and Trigonometry;*
Mathematics for Computing *Unit 5: Numeral Systems and Boolean Algebra; Unit 6: Algorithms and Computations;*
Mathematics for Engineering *Unit 5: Engineering Magnitudes and Scales; Unit 6: Motion and Vectors;*

Peer support on the day helped to solve a number of the problems highlighted. However, it was clear that the standard set in the vocational units in computing was too high. To address this problem the pilot practitioners recommended specific changes. In addition the practitioners also recommended that the final standard set for Mathematics at Level 2 should be deliverable by teachers of mathematics as well as vocational specialists. Revisions to the modules were made by the review group with immediate effect, and circulated to those involved in the pilot.

In June 2000, following year-end assessment, the pilot practitioners met again and gave the following feedback:

- the new modules were better than the existing module at level 2;
- learners liked the fact that the module was different from Leaving Certificate mathematics;
- regardless of background, at least some aspects of the module were new for all learners;
- learners liked the assignments which were radically different from an examination;
- the vocational approach made the subject more interesting to learners;
- there were still some concerns about aspects of the vocational computing units in Mathematics for Computing.

In terms of candidate achievement the 2000 results for both Mathematical Methods and Mathematics for Computing[3] are outlined below (Table 1).

Table 1: Results for NCVA Mathematical Methods and Mathematics for Computing June 2000

Module	Mathematical Methods	Mathematics for Computing
Grade	% of Candidates	% of Candidates
Distinction	12%	11%
Merit	16%	29%
Pass	27%	30%
Unsuccessful	45%	30%
Sample Total	100% (n=570)	100% (n=247)

Discussion

Creating a purposeful dialogue between practitioners and module designers is a challenging enterprise even when there is a willingness to engage. The benefits in this case are obvious to the authors and other members of the review group. There are still problems, as indicated by the unsuccessful rate that have to be addressed. Nevertheless significant progress has been made as indicated by the drop from 45% in the existing module to 30% in the proposed new module. These figures are greatly influenced by the prior mathematics/achievement of learners that in this case is dominated by low grades in the school Leaving Certificate (Mathematics). Indeed, it may well be that there is little scope for improvement here, however other outcomes of the pilot study are more encouraging.

A significant measure of agreement has been achieved between practitioners and the review group on the rationale and framework for adults' mathematics education under the aegis of NCVA, its content, pedagogy, and assessment. The new Level 2 Mathematics module has been endorsed by practitioners as being both teachable and learnable. Practitioners have contributed to the development of a support system including support notes and an informal practitioner network of peer support.

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[3] One centre completed Mathematics for Engineering with a very small number of candidates; these results have been excluded from this data.
Number of centres completing Mathematics for Computing = 5.

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In short, there is strong evidence that practitioners have now taken ownership of the new module and this, together with the new supports that have been fully endorsed by the review group, leads to optimism concerning the future success of mathematics education in the vocational context and a substantial reduction in the numbers of candidates that are unsuccessful.

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Organization/Address: DEPT OF MATHS & STATISTICS, UNIVERSITY OF LIMERICK, LIMERICK, IRELAND

Telephone: 353-61-202481

FAX:

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